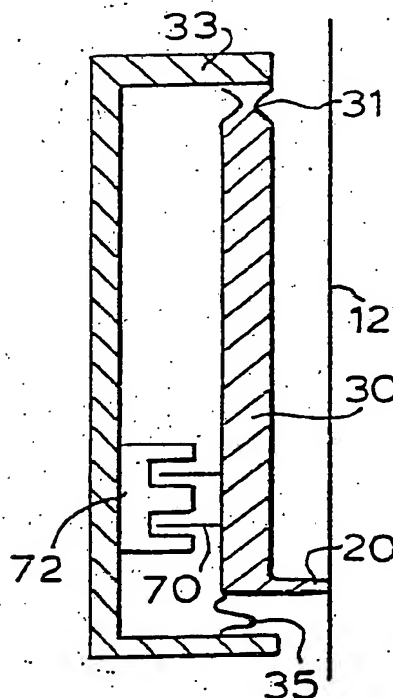


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>3</sup> :  <b>G10C 3/06</b>	<b>A1</b>	(11) International Publication Number: <b>WO 83/ 03022</b> (43) International Publication Date: 1 September 1983 (01.09.83)
(21) International Application Number: PCT/GB83/00060 (22) International Filing Date: 28 February 1983 (28.02.83) (31) Priority Application Number: 8205768 (32) Priority Date: 26 February 1982 (26.02.82) (33) Priority Country: GB (71) Applicant (for all designated States except US): PRU- TEC LIMITED [GB/GB]; 142, Holborn Bars, Lon- don EC1N 2NH (GB). (72) Inventor; and (75) Inventor/Applicant (for US only) : STANWELL- SMITH, Colin, Howard [GB/GB]; 18, Norman Ave- nue, Twickenham, Middx, TW1 2LY (GB). (74) Agent: MESSULAM, Alec, Moses; A. Messulam & Co., 24, Broadway, Leigh on Sea, Essex (GB).	(81) Designated States: AT (European patent), BE (Euro- pean patent), CH (European patent), DE (European patent), FR (European patent), GB (European pa- tent), JP, LU (European patent), NL (European pa- tent), SE (European patent), US.  Published With international search report. With amended claims.  Date of publication of the amended claims: 13 October 1983 (13.10.83)	

(54) Title: IMPROVEMENTS IN PIANOS



(57) Abstract

A piano in which a soundboard (30) connected to the strings (12) by a bridge (20) is constructed in the manner similar to the vibratable member of a loudspeaker. The piano may have separate soundboards for different frequency ranges. The soundboard may be connected to coils (70), (72) to act either as drives or as pick-ups. In this way background music may be played back through the piano or harmonics may be added by a processing circuit to vary the tone of the piano or achieve special effects.

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## AMENDED CLAIMS

[received by the International Bureau on 19 September 1983 (19.09.83)  
original claims 1 to 16 have been replaced by amended claims 1 to 14]

1. A piano comprising a frame, a plurality of taut strings supported on the frame and extending over a bridge and a soundboard coupled to the bridge, wherein  
5 the soundboard comprises a rigid member freely suspended relative to the frame by mounting means which enable the rigid member to move towards and away from the frame at least in the region of the bridge, characterised in that the frame (11) of the piano is of tubular construction  
10 and includes tubes (14) arranged between the strings (12) and lying in the same plane as the strings (12) and in that the bridges are connected to the strings by way of distance pieces (64).
2. A piano as claimed in claim 1, wherein the piano  
15 has a plurality of bridges (20,22,24) each connected to a respective soundboard (30,32,34).
3. A piano as claimed in claim 2, in which at least one (30) of the soundboards is supported relative to a sound box (33) by means of a flexible hinge arranged at  
20 a location remote from the bridge (20).
4. A piano as claimed in claim 2 or 3, in which at least one of the soundboards (32,34) is supported relative to sound box (44) by means of flexible and compliant support means (42) extending about the entire  
25 periphery of the soundboard.
5. A piano as claimed in claims 2, 3 and 4, having a first pivoted soundboard (30) connected to the strings of the base notes, and two further soundboards (32,34) each flexibly supported about its entire periphery.
- 30 6. A piano as claimed in any preceding claim, in which an electro-acoustic transducer (70,72) is connected to the or each soundboard (30,32,34).

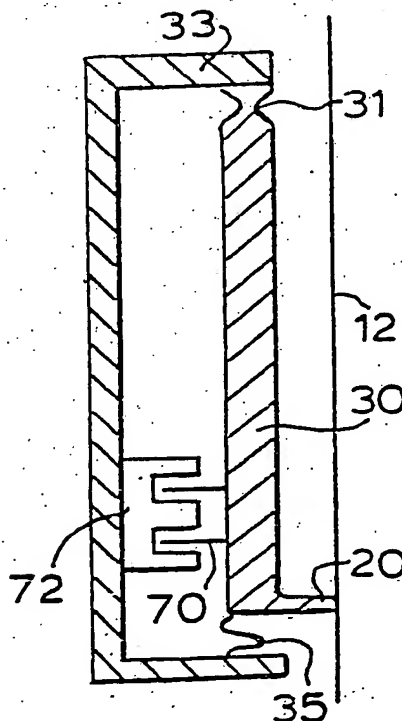
7. A piano as claimed in claim 6, in which the transducer is connected to act as a microphone.
8. A piano as claimed in claim 6 or 7 in which the transducer (70, 72) is arranged to act as a driver for superimposing on the vibration of the soundboard caused by the strings a sound derived from an external electrical source.
9. A piano as claimed in claim 8 wherein a play-back device is incorporated in the piano casing and connected to the transducer (70, 72), to enable play-back of pre-recorded background music using the soundboard as a loudspeaker.
10. A piano as claimed in claim 8, wherein the transducer (70, 72) is connected to a processing circuit which applies electrical feedback signals derived by processing signals produced by the struck strings.
11. A piano as claimed in any preceding claim, in which each bridge (20, 22, 24) is formed as an aluminium extrusion.
12. A piano as claimed in any preceding claim, wherein dampers for damping the strings are mounted in the space between the strings and the sound boards at the same level as the strike line of the hammers.
13. A piano as claimed in any preceding claim, in which the tubes (14) are interconnected by means of a bar (16) also serving to mount the action of the piano.
14. A piano as claimed in claim 13, in which the piano action is formed of a plurality of modules each having a predetermined number of hammers associated with the strings arranged between a pair of adjacent tubes (14).

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(54) Title: IMPROVEMENTS IN PIANOS		



## (57) Abstract

A piano in which a soundboard (30) connected to the strings (12) by a bridge (20) is constructed in the manner similar to the vibratable member of a loudspeaker. The piano may have separate soundboards for different-frequency ranges. The soundboard may be connected to coils (70), (72) to act either as drives or as pick-ups. In this way background music may be played back through the piano or harmonics may be added by a processing circuit to vary the tone of the piano to achieve special effects.

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## IMPROVEMENTS IN PIANOS

The present invention relates to upright pianos and the like stringed keyboard instruments.

5 In a conventional upright piano, the strings are mounted on a massive rigid frame and near their lower ends they extend over bridges which are attached to a soundboard rigidly secured to the piano casing and usually constituted by the back of the piano. Traditional soundboards are made of planks about 10mm  
10 thick laid edge to edge and braced at right angles by bars which run under the bridges. Great care is taken to select wood with high sound propagation rates and low internal damping. Overstringing is common because it allows a better bridge position on the sound board.  
15 However, problems arise because the base notes tend to be too near the edge of the soundboard and the treble notes lose volume because of the weight of the soundboard.

20 The present invention seeks to mitigate at least some of the foregoing disadvantages.

According to the present invention, there is provided a piano comprising a frame, a plurality of taut strings supported on the frame and extending over a bridge and a soundboard coupled to the bridge, wherein  
25 the soundboard comprises a rigid member freely suspended relative to the frame by mounting means which enable the rigid member to move towards and away from the frame at least in the region of the bridge.

Thus the invention proposes the use, as the  
30 soundboard of a piano, of a member analogous to the vibratable membrane of a loudspeaker.

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In the case of a relatively small soundboard, the rigid may be flexibly mounted about its entire periphery in the same manner as a loudspeaker cone but for larger soundboards the rigid member is preferably pivotable about an edge remote from the attachment to the bridge.

In the preferred embodiment of the invention, a piano comprises three bridges each connected to a respective soundboard. The soundboard for the base notes is pivotably mounted along a line remote from the bridge whereas the remaining two soundboards are flexibly supported in a rigid box by compliant mounting means extending about their peripheries.

In substituting the flexibly mounted vibratable member for the traditional soundboard, it is possible to draw on the experience in loudspeaker design not available to early piano designers.

The rigid box may be in the form of a closed box so as to use infinite baffle techniques and the box may be constituted by the casing of the instrument. Alternatively, the box may have a front opening and a base baffle in the manner used in some conventional loudspeakers.

It is well known that many loudspeakers separate low, medium and high frequencies in order to optimise the design. The same technique is used in the preferred embodiment of the invention by arranging a plurality of vibratable members each covering a different range of frequencies.

Since the vibratable members are similar to loudspeaker discs or cones, it is possible for each member to cooperate with an electrical coil which may act as a drive, a pick-up or both.

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The coil when used as a pick-up can enables sound recordings to be made directly from the soundboard of the piano. When used as a drive, it can, for example, enable a recorded piece of music to be reproduced while  
5 superimposing on the sound played back the notes manually played on the instrument. A still further possibility is that the sound produced by the strings may be modified by feedback whereupon special effects can be produced such as a swell effect.

10 To assist in the playing of background music, it is possible to incorporate in the instrument a play-back device such as a tape recorder.

The conventional frame used in a piano is extremely heavy and is rigid to withstand the  
15 considerable force exerted by all the tensioned strings. This has naturally contributed to the cost of the instrument.

In order to reduce the weight of the piano, it is proposed in the preferred embodiment of the invention  
20 that the frame be of tubular construction, comprising tubes not only about its periphery but also a parallel grid of tubes extending between the strings. Because of this construction each small group of strings is effectively framed separately and there is no longer the  
25 need for a long unsupported agraffe to withstand the tension of all the strings. Consequently, the frame members need not be as heavy and as rigid as in the prior art constructions.

Because of the presence of frame members between  
30 the strings, the strings cannot be connected directly to the bridges. In the preferred embodiment of the invention, distance pieces are interposed between the strings and the bridges, the latter being conveniently manufactured as an aluminium extrusion. Aluminium lends

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itself particularly well to such an application because of its acoustic properties and low density.

5 In a conventional upright piano, the proximity of the soundboard to the strings prevents any elements of the piano action from being positioned in this space. The optimum position for the dampers on a piano is immediately opposite the line of impact of the hammers. In a grand piano, this is readily achieved in that the strings are struck from below whereas the dampers rest  
10 on the strings from above under the action of gravity and are raised when the keys are depressed. However upright pianos have hitherto only been overdamped or underdamped, depending on whether the dampers act above or below the line of impact of the hammers and this has  
15 generally been acknowledged as inferior.

According to a preferred feature of the invention, the dampers for the strings are arranged in the space between the strings and the soundboards at the same level as the line of the hammers. The dampers may be  
20 actuated by means of extensions either of the piano keys or of the wippens, the extensions being arranged to extend between the strings.

The action of the piano may conveniently be mounted on a reinforcement bar connected between the  
25 tubes. Because the strings are divided into groups by the tubes reinforcing the frame, a modular approach may be adopted for the design of the action since a group of hammers may be separately formed and assembled on these tubes to strike the strings of the notes in that group.  
30 In this manner, the construction, initial assembly and repair of the action may be considerably simplified, to reduce the cost of the instrument.

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The invention will now be described further, by way of example, with reference to the accompanying drawings, in which :

Figure 1 shows a schematic view of a piano frame.

5      Figure 2 shows schematically the attachment of the bridges shown in Figure 1 to soundboards.

Figure 3 shows the mounting of the soundboard for base notes.

10      Figure 4 shows the mounting for the other two soundboards in Figure 2, and

Figure 5 shows the attachment of a string to a bridge.

In Figure 1, there is shown a frame which is made up of tubes. The frame (11) comprises an agraffe 10 to which all the piano strings 12 are connected by the usual arrangement for permitting the strings to be tuned. Unlike a conventional frame, the agraffe 10 is supported along its length by means of tubes 14 which form a grid extending between the strings 12. The frame is further strengthened by means of a bar 16 connected both to the outer members of the frame and to the tube 14. The bar 16 may serve to mount the action including the hammers etc. for striking the strings but this is not shown. Figure 1 also shows schematically the position of three bridges designated 20, 22 and 24 which are connected to the strings in a manner described below. Each string 12 is connected at its two ends to the frame but is stretched over a respective bridge which is not mounted on the frame but on a movable soundboard. The effective length of the string which determines the sound produced when the string is struck is the length between the bridge and the agraffe 10.

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The soundboards are rigid boards which are designed not to flex but to vibrate as a rigid body when a string is struck, to amplify the sound produced by the strings 12. The soundboard for the base notes, designated 30 in Figures 2 and 3, has the bridge 20 mounted at its lower end while at its upper end it is flexibly mounted on a hinge 31 which is secured to a rigid sound box 33. The sound box 33 is constituted by the casing of the piano. Around its periphery the soundboard 30 is connected by a flexible diaphragm 35 to the soundbox 33 so that the box acts as an infinite baffle. Thus the sound waves emanating from the side facing the strings 12 propagates in the forward direction while the sound waves in the opposite direction are suppressed. Because of the substantial weight of the soundboard 30, it is preferable to have a hinge at its upper end but the soundboard is nevertheless capable of oscillating as a rigid body to provide amplification. At its lower end, the sound board 30 is connected by the bridge 20 to several strings and this helps to support it.

In the case of the soundboards 32 and 34 in Figure 2 which are connected respectively to the bridges 22 and 24, these are mounted by a compliant support 42 which extends around the entire periphery to a sound box 44. This arrangement is shown in Figure 4. The soundboard 32 acts in a manner directly analogous to a loudspeaker cone.

It will be seen from Figure 1 that each of the bridges crosses one of the tubes 14 arranged between the strings 12. It is important from the point of view of ensuring the strength of the structure that the strings and the tubes be in the same plane. To enable the bridge to be securely mounted to the strings, distance pieces are provided between the bridges and the strings. This arrangement is shown in Figure 5 wherein the bridge 20

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is seen to be constituted by an aluminium extrusion 60 having a foot 62 secured to the soundboard 30. A tube 64 acting as a distance piece is arranged between the aluminium extrusion 60 and the string 12. A single  
5 string constituting a note (or two strings of the same note where applicable) are sandwiched between the distance piece 64 and a washer 66 which are in turn secured to the aluminium extrusion by means of a bolt 68 or the like. It is thus seen that the tubes 14 do not  
10 interfere with the extrusion 60 which constitutes the bridge and straddle the tubes 14.

Within each sound box 33 and 44, there is arranged a moving coil 70 secured to the respective soundboard and movable relative to a fixed magnet 72 to constitute  
15 an inductive transducer which can act either as a pick-up or as a drive. When the transducer is used as a drive the soundboard can be operated in the manner of a loud speaker to reproduce background music while the sounds produced by striking the strings of the piano may be  
20 superimposed directly onto the same soundboard.

Alternatively, the inductive transducer may be used as a microphone for recording the music played on the piano or may act as both an inductive pick-up and drive simultaneously. In this case, feed-back circuitry  
25 may be employed to modify the natural sound produced by striking the string to achieve swell effects and other special effects. The sound produced may be detected and processed in any manner desired, as known per se, and fed back to the same drive to modify the tone of the  
30 piano. As well as producing special effects, this technique can be used to alter the tone of the piano. If for example the feedback signal is constituted by harmonics of the same note of which the relative amplitude may be electronically selected, the instrument can  
35 provide some of the versatility of an electronic organ while retaining the advantages of a mechanical action.

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The use of aluminium in the bridge is particularly preferred because of its acoustic properties as well as its rigidity and light weight.

5 The spacing afforded by the distance pieces 64 and the bridge 60 can enable parts of the action of the piano to be incorporated within this spacing. In a preferred embodiment of the invention (not illustrated) this space is used to mount dampers which are arranged level with the strike line of the hammers. The dampers  
10 may be pivoted towards and away from the strings by the action of extensions of the keys or the wippens, these extensions passing between the strings. Apart from providing better damping than in conventional upright pianos, such a construction can also permit a shorter  
15 piano to be made since the hammers and the dampers are at the same level as opposed to the usual upright piano construction which employs dampers arranged above or below the hammers.

An important advantage of having separate  
20 soundboards for different notes is that the weight of the soundboards may be better matched to the strings to which they are connected and there is also more flexibility in the positioning of the bridges on the soundboard. The soundboards themselves may be made of  
25 any suitable light rigid material and as with loudspeaker cones they may be suitably shaped or strengthened to resist flexing.

It is possible to use the bar 16 to support the piano action and as the strings are divided into groups  
30 by the tubes 14 it is possible for the hammer actions to be made in groups or modules which are separately assembled onto the frame.

## CLAIMS

1. A piano comprising a frame, a plurality of taut strings supported on the frame and extending over a bridge and a soundboard coupled to the bridge, characterised in that the soundboard (30,32,34) comprises a rigid member freely suspended relative to the frame (11) by mounting means (31,35,42) which enable the rigid member to move towards and away from the frame (11) at least in the region of the bridge (20,22,24).
2. A piano as claimed in claim 1, wherein the piano has a plurality of bridges (20,22,24) each connected to a respective soundboard (30,32,34).
3. A piano as claimed in claim 2, in which at least one (30) of the soundboards is supported relative to a sound box (33) by means of a flexible hinge arranged at a location remote from the bridge (20).
4. A piano as claimed in claim 2 or 3, in which at least one of the soundboards (32,34) is supported relative to sound box (44) by means of flexible and compliant support means (42) extending about the entire periphery of the soundboard.
5. A piano as claimed in claims 2, 3 and 4, having a first pivoted soundboard (30) connected to the strings of the base notes, and two further soundboards (32,34) each flexibly supported about its entire periphery.
6. A piano as claimed in any preceding claim, in which an electro-acoustic transducer (70,72) is connected to the or each soundboard (30,32,34).
7. A piano as claimed in claim 6, in which the transducer is connected to act as a microphone.

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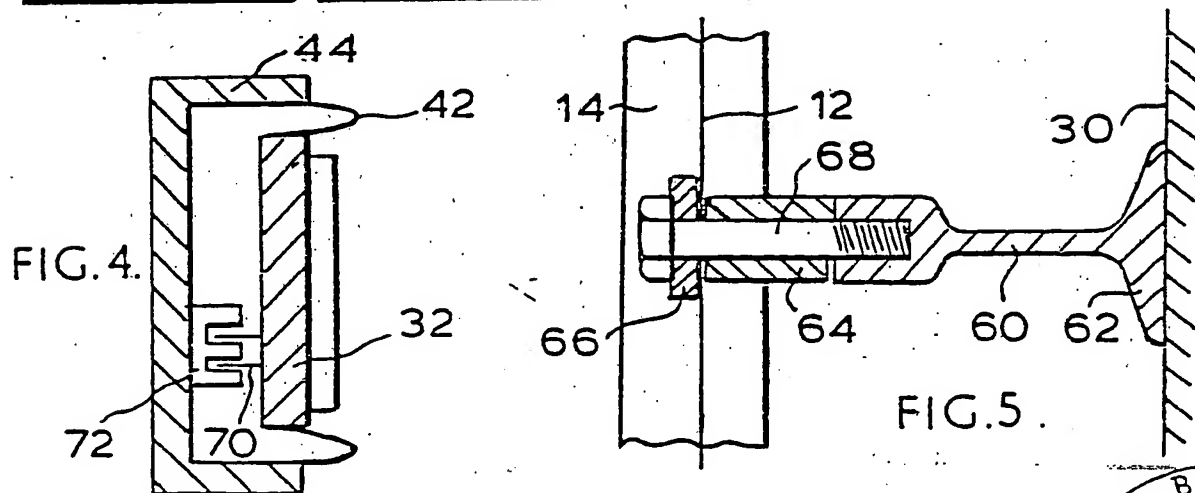
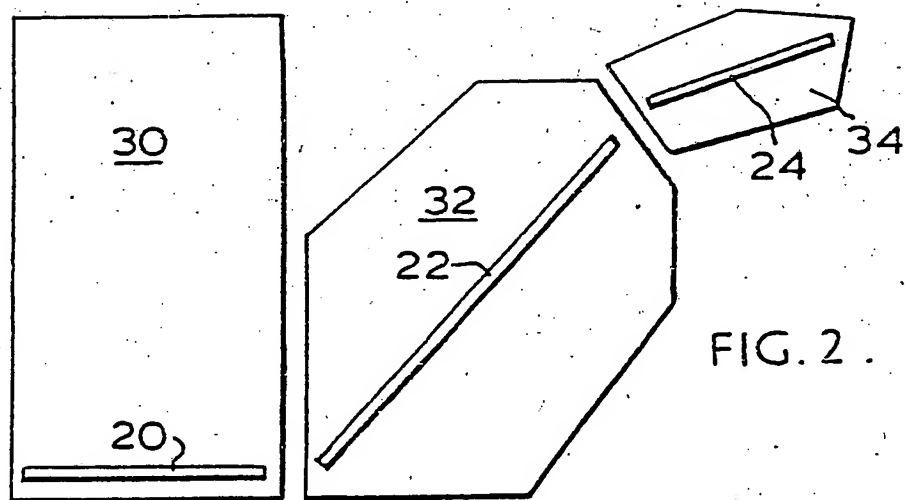
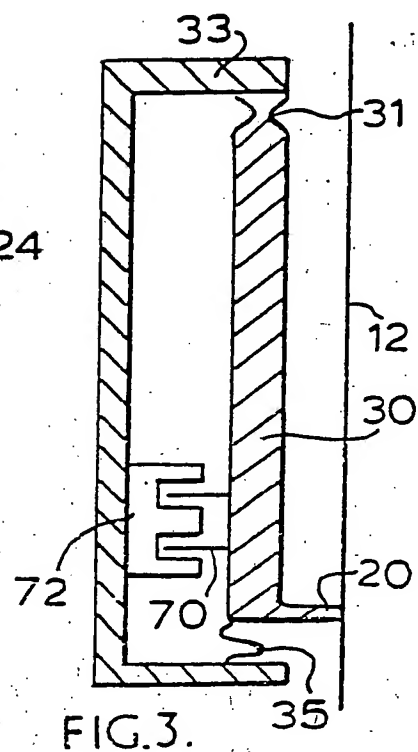
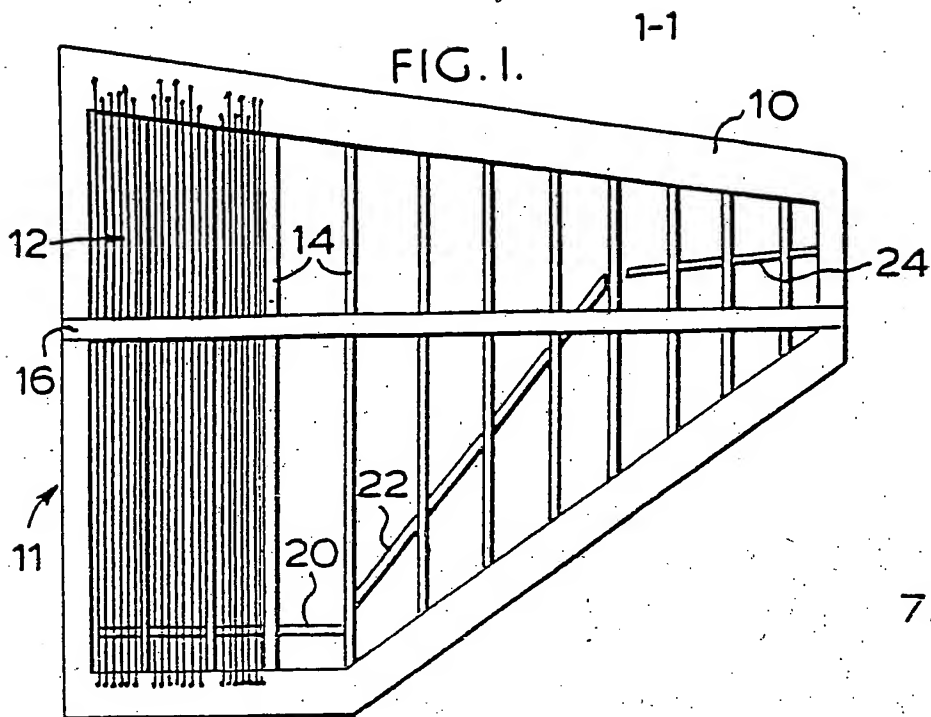
8. A piano as claimed in claim 6 or 7 in which the transducer (70, 72) is arranged to act as a driver for superimposing on the vibration of the soundboard caused by the strings a sound derived from an external electrical source.
9. A piano as claimed in claim 8 wherein a play-back device is incorporated in the piano casing and connected to the transducer (70, 72), to enable play-back of pre-recorded background music using the soundboard as a loudspeaker.
10. A piano as claimed in claim 8, wherein the transducer (70,72) is connected to a processing circuit which applies electrical feedback signals derived by processing signals produced by the struck strings.
11. A piano as claimed in any preceding claim, in which the frame (11) of the piano is of tubular construction and includes tubes (14) arranged between the strings (12).
12. A piano as claimed in claim 11, in which the tubes (14) lie in the same plane as the strings (12) and the bridges are connected to the strings by way of distance pieces (64).
13. A piano as claimed in claim 12 in which each bridge (20,22,24) is formed as an aluminium extrusion.
14. A piano as claimed in any preceding claim, wherein dampers for damping the strings are mounted in the space between the strings and the sound boards at the same level as the strike line of the hammers.



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15. A piano as claimed in claim 11 or any claim appended thereto, in which the tubes (14) are interconnected by means of a bar (16) on serving to mount the action of the piano.

- 5 16. A piano as claimed in claim 15, in which the piano action is formed of a plurality of modules each having a predetermined number of hammers associated with the strings arranged between a pair of adjacent tubes (14).



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 83/00060

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup> According to International Patent Classification (IPC) or to both National Classification and IPC IPC <sup>3</sup> :    G 10 C 3/06						
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched <sup>4</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px; vertical-align: top;">IPC<sup>3</sup></td> <td style="padding: 5px; vertical-align: top;">G 10 C; G 10 H</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup></div>			Classification System	Classification Symbols	IPC <sup>3</sup>	G 10 C; G 10 H
Classification System	Classification Symbols					
IPC <sup>3</sup>	G 10 C; G 10 H					
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>						
Category <sup>6</sup>	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>				
X,Y	US, A, 3312136 (H.K. GRAVES) 4 April 1967 see column 2, lines 8-21; column 3, line 60 - column 4, line 39; figures 1-4	1,3,4				
X,Y	GB, A, 1177463 (C.G. CONN LTD.) 14 January 1970 see page 3, lines 57-95; figures 3,5	1,2				
Y	DE, C, 572489 (A. FORSTER) 2 March 1933 see page 1, lines 25-33; page 2, lines 68-93; page 3, lines 14-56; figure 3	2,6,7				
A	DE, C, 151316 (A. BODEN) 13 May 1904 see claim; figure 1	4				
Y	FR, A, 754379 (L. POLLAK) 6 November 1933 see page 1, line 53 - page 2, line 50; figures 1,2	6-11				
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>15</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>						
<b>IV. CERTIFICATION</b>						
Date of the Actual Completion of the International Search <sup>1</sup> <div style="text-align: center; font-weight: bold;">6th July 1983</div>	Date of Mailing of this International Search Report <sup>2</sup> <div style="text-align: center; font-weight: bold;">26 JUL 1983</div>					
International Searching Authority <sup>1</sup> <div style="text-align: center; font-weight: bold;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <sup>20</sup> <div style="text-align: right;">             G.L.M. Krugenberg         </div>					

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No <sup>18</sup>
Y	GB, A, 320766 (W.E. DAVIS) 24 October 1929 see claim 1; figure 2 ---	6,9
A	US, A, 1929030 (B.F. MIESSNER) -----	

## ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO.

PCT/GB 83/00060 (SA

487

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 21/07/83

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Patent document cited in search report	Publication date	Patent family member(s)	Publicat date
US-A- 3312136		None	
GB-A- 1177463	14/01/70	US-A- 3477330	11/11/6
DE-C- 572489		None	
DE-C- 151316		None	
FR-A- 754379		None	
GB-A- 320766		None	
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